FROM THE "ASTRONOMICAL REGISTER."

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THE APPARENT CAUSE OF THE SUN'S VARIABLE DIAMETER.

Sir,—The short letter which you did me the favour of inserting in the *Register* for this month, on the "Variation in the Sun's Diameter," has been noticed by some of the members of the Astronomical Society. They are very desirous to obtain further particulars; which if you permit me, I shall be happy to give through the medium of your interesting and instructive periodical.

My friend Sir E. Belcher remarked at the *conversazione* on Saturday evening, that "the fact of the variable diameter of the sun being produced by atmospheric refraction, and not by the supposed variable distances, was known to him for many years, and that he quite agreed with my observations." Indeed, anyone who may visit the Equatorial zone and the Southern hemisphere, with a good sextant, and a vernier divided into 5″ or 10″, would necessarily arrive at the same conclusion—viz., that the variation in the diameter of the sun was produced by our atmospheric lens, which varied the sizes of the celestial bodies, and refracted their rays at a certain ratio, between the horizon and the zenith. The laws of atmospheric refraction are not yet ascertained with sufficient accuracy to be depended upon in all latitudes and altitudes; and this uncertainty has not only caused a misconception as regards the cause of the variation in the diameter of the sun, but also affects and vitiates many of what have hitherto been regarded as fundamental data of physical astronomy.

I should like to know how the maximum refraction has been computed equal to 33′, *i. e.*, in the horizon, as according to a series of observations carried on for many years near the equator I have only found it 16′ 30″—that is, equal to the apparent semi-diameter of the sun at its rising and setting.

The equatorial zone is very favourable for making delicate astronomical observations, inasmuch as the sky for days often remains tranquil and very transparent, and the temperature also is subject to but small variations, and the oscillation of the mercurial column very limited. These conditions are highly favourable for taking observations: therefore, I trust the following results deserve consideration and further investigation:—

	°	′	″	
The sun rising . . . ∠	0	32	55	diameter.
	15	32	35	
	30	32	18	
	45	31	55	
	60	31	32	
	75	31	6	

	°		′	″	
Noon	90		30	36	diameter.
	75		31	2	
	60		31	30	
	45		31	52	
	30		32	15	
	15		32	34	
Setting	0		32	56	

The above observations, and those following, were obtained by means of a good sextant and a repeating circle, and carried on for upwards of ten years near the equator.

In latitude 5° 10′ North, 300 feet above the sea—mean temperature 70°—I obtained the following results, measured in the meridian from tropic to tropic:—

	°	′	′	″	
South tropic ∠	61	22	31	30	Sun's diameter.
Equator	84	50	30	45	„ „
Zenith	90	0	30	36	„ „
North tropic	71	35	31	12	„ „

These variations of diameter, depending on the altitude, were subsequently confirmed by a series of observations in latitude 40° South.

Again, at Melbourne, latitude 38° South, I obtained the following results:—

	°	′	′	″	
June ∠	28	22	32	20	diameter.
Sept.	52	0	31	40	„
Dec.	75	27	31	0	„

Hence it follows that the ellipticity of the earth's orbit is founded on an optical illusion, which misled Kepler at a period when little was known of the laws of atmospheric refraction, and much less any opportunity at that time, to make counter observations in the Southern hemisphere. The supposed variable velocities proceed from the same cause; hence one illusion neutralises the effects of the other.

I remain, Sir, yours very faithfully,

E. HOPKINS, C.E., F.G.S.

June 14, 1864.

P.S.—I beg leave to correct an error in my last letter. The sun's diameter at the altitude of 22° is 32′ 22″, and not 32′ 32″, as therein inserted. The atmosphere should be perfectly transparent and serene, and the same shades employed, to insure correct results. E. H.

THE MOON'S PATH ROUND THE EARTH.

Sir,—Mr. Reddie is astounded at my ignorance of the fact that the moon's path, if drawn to a scale of an inch to a million of miles, would never diverge, by a quarter of an inch, from a circle round the

sun. No doubt this is the case, as is shown by your correspondent "S. B.;" but in the illustrations generally used on this subject the moon's path is spoken of relatively to the earth. Mr. Reddie, apparently, insists that what is said shall be founded upon abstract movements in space, and forgets that, being imperfectly acquainted with such movements, we can found no arguments upon them. Speaking of a carriage wheel, we say, "it turns round," although it does not actually turn *round,* the movement of the carriage complicating the simple rotation of the wheel. So of the moon: we say she revolves in "an ellipse round the earth;" which is not actually the case, because the movement of the earth complicates that ellipse.

"Ruricola" states that I reiterate the assertion that "the moon does not rotate *because* she does not." I should like him to point where I have done so. As I said before, I asked a simple question: when he has answered it, he may begin to talk of the "sex" of my argument.

I am, Sir, obediently yours,

AN ENQUIRER.

Cambridge: June 10, 1864.

THE FOUCAULT PENDULUM EXPERIMENT.

Sir,—As the "Moon Controversy" seems to have culminated, and I would fain hope has exhausted itself, it has occurred to me that some notice of the *Foucault pendulum experiment*, as an additional proof of terrestrial axial rotation, would be a suitable subject to occupy a small portion of the space in the *Register* thus set at liberty. What I was thinking of is, whether some one able and willing to communicate, and who has thoroughly mastered the subject so as to make the experiment uniformly satisfactory, might be induced to give a statement of all the conditions necessary to be complied with in order to uniform success. In Professor Arago's *Popular Astronomy*, numerous particulars are given, with cuts; he recommends suspension by steel wire: it seems to me, although I feel not qualified to give an opinion, that the cord of suspension, although it should originally be perfectly free from torsion, should most easily admit of it. I find many of those who have seen the experiment tried, even in large towns and under the auspices of public bodies, are sceptical, and doubtful even whether there be anything in it. I am not at all with these, although I have not yet succeeded in it perfectly and uniformly. If it be possible, however, I hope to do it. The subject generally is pretty extensively discussed and the theory of it explained, in the *Mechanics' Magazine*, vol. 54, 1851.

I am, &c.

Thornton-in-Craven,
1864-5-24.

T. W.

ON THE MISAPPLICATION OF SCIENTIFIC TERMS.

Sir,—I presume that the object of a scientific periodical is not only to disseminate the opinions and hypotheses of our scientific men, but also to furnish satisfactory explanations on dubious questions, and render the subjects clear to common-sense. It is to be hoped that our philosophers, at least, will always be ready and happy to enlighten any of your correspondents in a becoming spirit, when they respectfully apply for information or explanation on any point which they might not comprehend. It is somewhat painful to observe the tendency of some writers to ridicule plain questions instead of giving discreet answers; but I trust such an abuse of scientific discussions will not again appear in your valuable pages.

The remark made in the letter which you did me the favour of inserting in the *Register* for this month, with reference to the misapplication of the terms *rotation* and *revolution*, improperly used as synonymous by eminent scientific writers, has caused enquiry, and I am called upon to prove the assertion. I trust, therefore, you will permit me to quote two examples to confirm my statement.

In Herschel's *Outlines of Astronomy*, 5th Edition, article 434, On the Moon:—"The remarkable coincidence of the *two rotations*, that about the axis and that *about the earth*," &c. The motion of the moon round the earth is thus represented as rotation!

In the *Nautical Almanac* for this year, page 511, we find the following:—"The *revolution* of the earth on *its axis* is always performed," &c.

The rotation of the earth on its axis is incorrectly called revolution. I could quote other instances of such misapplication of these terms in the writings of the Astronomer Royal and others; but I hope the above will be sufficient to satisfy your readers that my observation was strictly correct. Kepler was a geometrician and an astronomer, and justly remarked that "the moon *revolved* round the earth, but was *not endowed with rotation*."

At that period the simple "circular motion" was not trammelled by any imaginary tangential forces or straight lines, which subsequently led to the confused and unsatisfactory unity of the composition of forces and the laws of geometry, which are incapable of being proved correct to this date.

I am, Sir, yours very respectfully,
E. HOPKINS, C.E., F.G.S.

15 Clarendon Gardens, Maida Hill, W.
May 18, 1864.

THE MOON CONTROVERSY.

Sir,—I ask leave to point out the utterly groundless assumption on which your correspondents are proceeding, who deny the fact of the moon's rotation on her axis. The very phenomenon on which they rely in support of their opinion refutes them. *Speaking roughly*, the moon presents constantly the same face to the earth; but *in strictness this is not true*, and the discrepancy is destructive of their argument, which I take to be this:—"The moon has not two independent motions—one of revolution round the earth, and another of rotation round her own axis, but the former only, in consequence of which

she presents, &c." Now, one part of the *librations* is due to the want of exact uniformity between the two *independent* motions, and could not exist were their theory correct. "The moon's rotation on her axis is *uniform*; but since her motion in her orbit is *not so*, we are enabled to look a few degrees round the equatorial parts of her visible border, on the eastern or western side, according to circumstances, &c."—*Herschel's Astr.* art. 435. What other explanation could possibly be given of this? It is owing to the phenomenon of the libration that stereoscopic views of the moon can be taken, and then the two different movements are in a manner made visible.

I am surprised that none of your correspondents have suggested the following experiment:—Suspend a ball from any convenient place, and having drawn it out of the perpendicular, cause it to revolve round its position of rest. If care has been taken, in starting it, not to give it an axial rotation, it will not acquire one during its revolution, but the same point in the surface will point constantly towards the same part of the room. Then the conclusion is obvious—either the moon rotates or this ball does, for (roughly speaking) the moon presents the same hemisphere to the centre of its orbit; but the ball presents a continually-changing hemisphere. Which is it that has rotated?

Yours faithfully,

P.

London: June 18, 1864.

Sir,—In this controversy, how does it happen that the third body, the sun, is never referred to? The moon moves round the earth, presenting always *the same* face or hemisphere to the earth. Some persons deny that this compound motion includes a rotation of the moon upon her axis. But to completely prove their theory or view, these deniers should go farther, and should prove affirmatively, that a body which should move round the earth, and should present to it *different* faces or hemispheres in the course of that motion, *does rotate* on its axis. The direction of the lines of the sun's light may be assumed to be parallel during one lunation.

T. H.

Sir,—Taking Mr. Deey's equations of motion $x=a \cos \phi \pm e \cos \lambda$, $y=a \sin \phi \pm e \sin \lambda$, the two parameters a, e, are reducible to one in making $\lambda=\phi$, for then $x=(a \pm e) \cos \phi$, $y=(a \pm e) \sin \phi$, which involving only one parameter or radius $a \pm e$ denotes a single circular movement; and this is the only relation between the angles ϕ and λ which will produce it: this is precisely the case of the moon revolving round the earth at rest. In making $\lambda=\phi$ the equations of motion become $x=(a \pm e) \cos \phi$, $y=(a \mp e) \sin \phi$, and therefore $(a \pm e)^2 y^2 + (a \mp e)^2 x^2 = (a \pm e)(a \mp e)$, the equations of an ellipse, and involving two parameters $a \pm e$ and $a \mp e$ not reducible to one, indicating two angular movements in contrary directions, one of which is double the other, the well-known characteristic of ellipsic motion.

If $\lambda=2\phi$, the equations of motion become $x=a \cos \phi \pm e \cos 2\phi$,

$y=a \sin \phi \pm e \sin 2\phi$, which, if $a=2e$, are the equations of the common cardiode, where the angular movements are equal and in the same direction. Reciprocally, when the angular movements are equal, but in contrary directions, the equations of motion become $x=a \cos \varsigma \pm e$, $y=a \sin \varsigma$, and therefore $(x \mp e)^2+y^2=a^2$; involving the two parameters a and e, and denoting an excentric circle whose radius= parameter a, and excentricity=parameter e.

Different values of e give different circles, all having the common value $2a$ for their diameters: y remains the same for all values of e, and consequently the parameter e throughout its motion remains constantly parallel to the axis of x. Whereby it is demonstrated that parallel circular motion is a compound motion, and not a simple or single movement.

Thus Mr. Deey's own equations, *when rightly interpreted*, give the same results as those of

ANALYST.

June 1864.

Sir,—Mr. J. T. Slugg has, like many more, confounded revolution with rotation. His argument will be found, upon examination, to support the opposite theory to that he intended. Let D, rotating on a stationary axis, be removed to M. As D rotates, the indicator will point at one time towards E, and at another in the opposite direction; and it is evident that, during half the period of rotation, the indicator will be visible to an observer at E, but invisible to him during the other half. "We have already seen that neither progress in rotating, nor a slow rate of rotation, in the least indicates the fact of rotation, nor in fact has anything at all to do with it." If, therefore, we suppose D to revolve about E in the same time as it takes to make one rotation on its axis, the same appearance will be presented to the observer at E; and if the indicator be a spot on the lunar surface, it will, supposing this axial rotation, appear for 14 days to the observer at E, and then, disappearing over the edge of the visible half of the moon's surface, remain for a similar period invisible to him. But this phenomenon is not exhibited by the moon, the surface of which remains the same to an observer on the earth during the whole period of her revolution. It is evident, therefore, that she does not rotate on her axis.—I am, Sir,

Yours obediently,

S. B. K.

Sir,—Your correspondent, "Query," requests, in the last number of the *Register*, a categorical answer to the following three questions:—

1st. In rotation on an axis is it not necessary that the axis should be within the body rotating?

2nd. That one side of the rotating body shall travel in an opposite direction to that of the other side?

3rd. That all objects at a distance shall appear to be travelling in opposite directions to that of the direction in which the outside of the rotating body travels?

In reply to the first question, rotation on an axis of course means an axis within the body. In philosophical language a body moving freely in space is capable of two kinds of motion, namely, one termed a motion of translation referred to axes fixed in space and outside the body; the other, a motion of rotation about axes fixed *in* the body and moving within it.

In reply to the second question, if one point of a rigid body is moving in a given direction, every point of that body rigidly connected with it must of course be moving in the same direction. I cannot conceive how your correspondent could think that one point of a body could travel in one direction, and another point in the same body in an opposite direction.

As to the third question. If a body is moving in a given direction, every object outside of it would appear, to a spectator on the moving body, to be travelling in a direction opposite to that in which the body is going; from this last point may be deduced the best proof for the double motion of the moon, viz. one a motion of translation with respect to the earth, which is outside of it, and another of rotation about an axis in itself, in a contrary direction to the first; for if only the motion of translation existed, say from left to right, the earth would appear, to a spectator in the moon, to be moving from right to left, and would therefore quickly pass out of his range of vision, whereas we know that the same spot on the moon is always presented to the earth; but the other motion of the moon, viz. that of rotation on its axis from right to left, would cause the earth to appear to move from left to right, and would therefore cancel the effect of the motion of translation, which made the earth appear to move from right to left. Hence the two motions of translation and rotation, in opposite directions, cause the earth to appear fixed, to a spectator standing on the same spot in the moon, and this is the effect which we know to be produced.

Q. E. D., A CAMBRIDGE GRADUATE.

Sir,—In speaking of a subject as delicate as that of the moon, we ought to consider—with the ancient Romans—that all due deference and honour are worthy of being assigned to its presiding deity, that is, in point of refinement and gallantry we ought to take more pains, and endeavour to adjust and reform the *truth* from the various absurd ideas that have crept in among us; and to speak of the different effects peculiar to the moon in a systematic and reasoning point of view, and not in a rambling, shuffling kind of way, which some of us are liable to do. If it were not practicable to carry out the idea an M.A. has given us, of having a "public meeting," would it not be easier to ascertain on which side the majority of votes lay, by referring to the different statements and letters of your various correspondents with regard to the moon controversy? Allow me to suggest an idea that (if possible to be carried out) might disprove or confirm the various opinions of any individual, of course including those of your correspondents. Let us construct, or imagine to be so, a sort of machine that would illustrate the motions and peculiarities of our earth and the heavenly bodies. 1st. Let there be a round globe, or if not that, a frame, sufficiently large to contain a man (fastened in) with his head projecting out to illustrate the earth and an observer on the earth. Let this frame be placed upon an axle or two pivots, and let it be turned round slowly to represent the *diurnal* motion of the earth; while turning round on its axis, let it be also carried round a *centre*, to illustrate the motion of the earth with regard to the *sun* or its *annual* motion. Next, let a small globe be placed so as to represent the *moon*, and let it also partake of some motion, whether it be on its *own* axis, or in a motion similar to the earth. Then put a strong light *above*, likewise to represent the *sun*. Let the rays emanating from it strike on the small globe (or moon) so as to lighten up one half and leave the other in darkness: we should then ascertain the mode in which the moon appears to us when either a *new* moon or *full*, or even in the medium. If the results do not appear as we see it naturally, by letting it turn on its *own* axis, then let it be tried by allowing it to turn in a way similar to ours "*alone*." The experiment, I confess, would seem rather difficult to prove, but I should think would be the only way of *proving* the subject under discussion. Apologising for trespass on your space,

I remain, Sir, yours faithfully,

"ONE WHO IS MOON-STRICKEN."

London: June 2, 1864.

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